

APPENDIX M

GEOTECHNICAL CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN FOR CONSTRUCTION OF THE FINAL COVER SYSTEM

**GEOTECHNICAL CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN
FOR CONSTRUCTION OF THE
FINAL COVER SYSTEM
AT GREGORY CANYON LANDFILL**

Prepared for:

**Bryan A. Stirrat & Associates
16885 West Bernardo Drive, Suite 305
San Diego, California 92127**

Prepared by:

**GeoLogic Associates
16885 West Bernardo Drive, Suite 305
San Diego, California 92127**

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INTRODUCTION

A Construction Quality Assurance (CQA) program consists of selected testing, inspection and documentation of a final construction product in order to provide the Owner/Agencies an evaluation of whether the end product is of the specified quality of materials and workmanship. Because of possible conflicts of interest, the Contractor should not undertake the CQA function directly. Rather, CQA inspection and testing should be left under the objective authority of a single team of design and inspection professionals.

A Construction Quality Control (CQC) program consists of selected tests and inspections performed by the Contractor during production, which can assist the Contractor in producing the quality product required. While the CQC function is the sole responsibility of the Contractor, the Project Manager may, at his/her discretion, provide information regarding the ongoing CQA monitoring for the Contractor's use in implementing his/her CQC function. Release of the CQA data to the Contractor would be for convenience only and would, in no way, relieve the Contractor from the responsibility to fulfill the project requirements.

Construction of final cover improvements for the Gregory Canyon Landfill consist of constructing individual discrete layers of earth and synthetic materials which will function as a unit to form the containment system for the waste management area. As proposed, the final cover for the Gregory Canyon Landfill will consist of from bottom to top: placement of a 2-foot thick foundation layer composed of random soil materials; installation of LLDPE geomembrane over prepared subgrade; installation of a geocomposite drainage media on relatively flat deck areas; and placement of a two (2)-foot thick vegetative soil layer.

Each of these components functions as an integral part of the final cover system and consequently must become a finished project during the course of construction. As a result, it is important that each layer or component of the cover system be completed to the design specifications prior to construction of successive or overlying layers. For this reason, it is both inefficient and impractical to withhold CQA testing until completion of the cover and it is necessary to conduct an ongoing CQA program during construction to verify a quality end product.

This document presents the geotechnical CQA criteria for construction of the earthwork and geosynthetic portions of the final cover system for the Gregory Canyon Landfill in San Diego County, California. This CQA Plan is to be used in conjunction with the Project Drawings and Specifications to ensure that the proposed final cover system is constructed in accordance with applicable regulatory guidelines.

1.1 PROJECT REQUIREMENTS

As currently proposed, final cover improvements for the Gregory Canyon Landfill will be composed of the following elements:

- Placement of a two (2) foot thick foundation layer composed of random soil materials;
- A 60-mil linear low-density polyethylene (LLDPE) geomembrane placed over prepared subgrade;
- A geocomposite drainage media placed over the LLDPE on relatively flat deck areas; and
- A two (2)-foot thick vegetative cover soil layer composed of approved on-site soil materials.

All materials used to construct the final cover must meet or exceed the criteria established for each particular layer of the system as indicated on the Project Drawings and Specifications. Any deviation from the Specifications must be pre-approved by the Geotechnical Consultant and/or Engineer.

2.0 RESPONSIBLE PARTIES AND DEFINITIONS

2.1 RESPONSIBLE PARTIES

The responsible parties for all post-closure construction activities, as set forth herein, are as follows:

Property Owner

Gregory Canyon Ltd.
3 Embarcadero Center, Suite 2360
San Francisco, California 94111
Contact: General Manager
Phone: (415) 391-2833

Landfill Engineer

Bryan A. Stirrat & Associates
1360 Valley Vista Drive
Diamond Bar, California 91765
Contact: Mr. Michael Cullinane
Phone: (909) 860-7777

Geotechnical CQA Consultant

GeoLogic Associates
1360 Valley Vista Drive
Diamond Bar, California 91765
Contact: Mr. Gary L. Lass
Phone: (909) 860-3448

2.2 DEFINITIONS

"Construction Manager" – Person(s) or firm(s) authorized by the Owner to manage and oversee the administration of the Construction Contract. All CQA functions will be under the direct authority of the Construction Manager. All coordination, reporting and issues related to non-compliance will be directed through the Construction Manager. In addition, he/she will participate with the Landfill Engineer and Geotechnical CQA Consultant in all decisions related to design issues, which arise during the course of construction.

"Contract or Contract Documents" - The Contract or Contract Documents shall consist of the Notice Inviting Bids, Instructions to Bidders, Proposal, Agreement, Faithful Performance Bond, Labor and Material Payment Bond, General Conditions, Supplementary General Conditions, Special Provisions, and drawings or plans.

"Contractor" - The firm responsible for all elements of construction. In this regard, the Contractor's responsibility includes but is not limited to: overexcavation and subgrade preparation; preparation of the supporting surfaces (generally soil) for the geosynthetic installation; installation of the geosynthetics; and placing earth materials over the installed synthetic systems. The Contractor is further responsible for all activities of Subcontractors including but not limited to the geosynthetics Subcontractor.

"Geomembrane" - An essentially impermeable synthetic material used as an integral part of a cover system. It is sometimes referred to as a FML, sheet, or panel. For this project, the geomembrane consists of 60 mil LLDPE.

"Geosynthetics" - A generic classification given to synthetic (man-made plastic and fabric) materials used in geotechnical and construction applications. Included are geomembrane liners, geotextiles, geosynthetic clay liner (GCL), geocomposites, geogrids, geocomposites and geocells. For this project, the term geosynthetics is used to refer to the geomembrane, geocomposite and geotextiles.

"Geosynthetic Subcontractor" - The firm, if other than the Prime Contractor, responsible for handling, storing, placing, seaming, and other aspects of the installation of the geosynthetics included in the cover system.

"Geotechnical CQA Consultant" - Geotechnical firm responsible for the design and specifications for earthwork and geosynthetic elements of the Project Drawings and Specifications. The Geotechnical CQA Consultant or his/her representative is also responsible for observing, testing, and documenting activities related to quality assurance for all geotechnical and geosynthetic aspects of construction except for engineering and survey control. All completed geotechnical work is subject to approval by the Geotechnical CQA Consultant.

"Geotechnical CQA Monitors" - The individuals working under the direction of the Geotechnical CQA Officer who are routinely involved in the construction process. Such personnel include "Geotechnical Technicians", "Field Engineers" and "Field Geologists" representing the Geotechnical CQA Consultant. CQA Monitors shall be experienced in landfill construction monitoring, compaction observation and testing during grading operations, and geosynthetic material observation, monitoring and documentation.

"Geotechnical CQA Officer" - The individual or firm serving under the direction of the Geotechnical CQA Consultant and responsible for the day to day geotechnical Construction Quality Assurance (CQA). The Geotechnical CQA Officer shall be a California registered civil engineer or a certified engineering geologist with specific experience in managing landfill final cover construction projects.

"Geotechnical CQA Project Director" - Geological/geotechnical professional registered in the State of California who, under the employ of the Geotechnical CQA Consultant is responsible for earthwork observation, monitoring and testing.

"Geotechnical Construction Quality Assurance for Earthwork" - The protocols to be followed in evaluating the adequacy of the Contractor's work with regard to all elements of earthworks construction with the exception of line and grade (survey) control. Said work shall include but need not be limited to all CQA activities delineated herein and in the Specifications. Geotechnical CQA is to be provided by a party independent of the Contractor.

"Geotechnical Quality Assurance for Geosynthetics" - The protocols to be followed in evaluating the quality of the Contractor's work with regard to all elements of geosynthetic installation with the exception of line and grade (survey) control. Said work shall include but need not be limited to all CQA activities delineated herein. Geotechnical CQA for geosynthetics is to be provided by a party independent of the liner manufacturer, Contractor and liner Subcontractor.

"Geotextile" - A permeable synthetic textile used with soil, rock, sand, gravel or any other similar materials as an integral part of the composite liner system. It can provide protection to other systems or serve to separate different materials.

"Independent Testing Laboratory" - The firm responsible for conducting selected tests of materials and/or products used for the project, such as conformance and destructive seam testing. The laboratory shall be independent of the Owner, County, Manufacturer, Geosynthetics Subcontractor and any party involved with the manufacture and/or installation of any product to be tested.

"Landfill Engineer" - The firm responsible for the design and preparation of the Project Drawings and Specifications. The Engineer or his representative is also responsible for observing, testing, and documenting activities related to quality

assurance for all aspects of construction. All completed work is subject to approval by the Engineer.

"Liner Manufacturer" - Firm(s) responsible for the production of the geosynthetic material.

"Liner Subcontractor" - The firm responsible for handling, storing, placing, seaming, and other aspects of the installation of the geosynthetics included in the project.

"Lot" - A quantity of relatively uniform geosynthetic material produced using a specific, identifiable constituent mix. For instance, the geomembrane manufacturer receives a specific resin batch from his/her supplier and produces from it a specific "Lot" of finished product.

"Owner" - The owner of the site, in this case Gregory Canyon Ltd.

"Project Documents" - All Contractor submittals, Construction Drawings, Record Drawings, "As-Built" Plans, Construction Specifications, CQA Plan, Health and Safety Plan and Project Schedule.

"Project Manager" - The Owner's designated representative responsible for the Project.

"Quality Assurance" - Actions taken by the Owner or his representative(s) necessary to evaluate whether the earthen and geosynthetic materials and workmanship meet the requirements of the Project Drawings and Specifications.

"Quality Control" - Actions taken by the Contractor, Subcontractors and/or Liner Manufacturer(s) to ensure that the earthen and geosynthetic materials and workmanship meet the requirements of the Project Drawings and Specifications.

"Work" - All tools, equipment, supervision, labor, and materials or supplies necessary to complete the project as specified herein and as shown on the Project Drawings.

3.0 GEOTECHNICAL CQA ORGANIZATION

The Geotechnical CQA Team will consist of design and field personnel with specific experience in the inspection and CQA monitoring of earthwork and geosynthetic materials and installation related to landfill cover construction. The principal categories of personnel assigned to the CQA team are presented below.

3.1 GEOTECHNICAL CQA PROJECT DIRECTOR

The Geotechnical Project Director shall be a representative of the Geotechnical CQA Consultant and shall have overall responsibility for all geotechnical CQA activities and have specific experience in managing landfill final cover construction projects.

The Geotechnical Project Director shall be a California registered civil engineer or certified engineering geologist and will be responsible for reviewing all earth material or excavation issues, which may arise during construction. The Geotechnical CQA Project Director's approval will be required for any earth or geosynthetic material modifications or for any design modifications, which may impact the performance of the earth or geosynthetic materials.

3.2 GEOTECHNICAL CQA OFFICER

The Geotechnical CQA Officer will serve as the Geotechnical Project Director's representative. All geotechnical CQA functions will be his/her direct responsibility. All coordination, reporting and issues related to non-compliance will be directed from the Geotechnical CQA Officer through the Construction Manager. In addition, the CQA Officer will participate with the Landfill Engineer and Geotechnical Project Director in all decisions related to design issues, which arise during the course of construction.

The Geotechnical CQA Officer shall be responsible for overall review of observation, sampling, and testing activities during construction. The CQA Officer shall have prior experience serving as the CQA Officer on similar final cover construction projects. Specific duties of the CQA Officer include, but are not limited to the following:

- Review of all Designs, Project Drawings, Specifications and Contractor Submittals.
- Implementation of the Geotechnical CQA Plan including assignment and management of CQA personnel; review of field reports; and geotechnical review of CQA related issues.
- Review of design changes and coordination of such changes with the Landfill Engineer.
- Familiarization of all Geotechnical CQA Monitors with the site and the Geotechnical CQA requirements.
- Attendance at all CQA related meetings, (i.e., preconstruction, progress and special meetings as required).
- Coordination of all field testing, sampling, and laboratory testing.
- Review of all field and laboratory test results and provide recommendations as appropriate.
- Review all Geotechnical CQA Monitors daily reports and logs for completeness and documentation.

- Notation of any on-site activities or conditions that could jeopardize the quality or function of the final cover system and reporting of these activities or conditions to the Construction Manager.
- Designation of a Senior Geotechnical CQA Monitor to act on his/her behalf at the site while he/she is absent and operations are ongoing.
- Reporting of any unresolved issues and/or deviations from the Geotechnical CQA Plan to the Construction Manager and/or the Landfill Engineer as appropriate.
- Preparation of the final "As-Built" report for all completed earthwork construction activities.
- Participation in the preparation of the Record Drawings.

3.3 GEOTECHNICAL CQA MONITORS

3.3.1 FIELD ENGINEER/FIELD GEOLOGIST

The Field Engineer/Field Geologist will be a representative of the Geotechnical CQA Consultant and will be assigned to monitor and evaluate earth materials conformance with the requirements of the Project Drawings and Specifications. Each Field Engineer/Field Geologist will have specific experience in landfill construction monitoring, compaction observation and testing during grading operations, and geosynthetic material observation, monitoring and documentation. Duties of the Field Engineer/Field Geologist typically include the following:

- Subgrade inspection, review, testing and documentation.
- Review of the adequacy of all clearing, grubbing, stripping and preparation of areas to receive fill.
- Monitoring and evaluation of any soil blending, mixing and processing operations.
- Evaluation of the engineering characteristics of the processed and constructed earth materials.
- Observation and evaluation of all excavations which may be impacted by geologic conditions.

3.3.2 GEOTECHNICAL CQA FIELD TECHNICIANS

Geotechnical CQA Technicians will be representatives of the Geotechnical CQA Consultant and will monitor and observe grading operations and geosynthetic installation to provide a basis for concluding that construction has been carried out in conformance with the Project Drawings and Specifications. Duties typically include, but are not necessarily limited to:

- Observation of subgrade surface preparation.
- Verification that cover soils are derived from appropriate sources.
- Visual evaluation of the soils physical properties for consistency with the Project Drawings and Specifications.

- Evaluation of all moisture conditioning and processing operations to evaluate uniformity of material and moisture content.
- Evaluation of the constructed engineered fill material for conformance with the Project Drawings and Specifications.
- Identification of deleterious materials or other deficiencies in soil characteristics to minimize the possibility that these materials are incorporated into the cover system.
- Monitoring of activities for the removal and/or disaggregation of all oversize material.
- Observation of uniformity of coverage of compaction equipment, especially at fill edges, turnaround areas and on slope faces.
- Monitoring of lift thickness.
- Observation of the active fill pad at the beginning of each grading day and establishment of requirements for wetting/drying and/or processing of exposed surfaces prior to placement of additional fill.
- Undertaking field tests including but not limited to field moisture/density testing at the minimum frequencies noted herein or at any time that a deficiency is suspected.
- Recovery of samples for laboratory testing.
- Evaluation and documentation of laboratory and field testing of the in-place moisture content and density of engineered fill materials in accordance with the requirements of the Specifications (including retests, if necessary).
- Confirmation that the test results are in accordance with the Project Specifications (including retests of any previously failed areas).

The operations to be monitored for geosynthetics typically include, but are not necessarily limited to:

- Material delivery.
- Unloading and on-site transport and storage.
- Placement/deployment operations.
- Joining and/or seaming operations.
- Repair operations.

Specifically, the seaming operations to be monitored include:

- Trial seams.
- Seam preparation.
- Seaming.
- Nondestructive seam testing.
- Sampling for destructive seam testing.
- Laboratory test sample marking.
- Repair operations.
- Reviewing the final certification of seams.

In addition to these specific duties, the Geotechnical CQA Technicians shall be responsible for:

- Observing the condition of geosynthetic materials as placed.
- Selecting samples for conformance testing by the Independent Testing Laboratory.
- Marking samples for conformance testing.
- Notation of any on-site activities that could result in damage to the geosynthetics.

All observations shall be reported in a timely manner to the Construction Manager.

3.4 INDEPENDENT TESTING LABORATORY

The Independent Testing Laboratory shall perform all conformance testing of geosynthetics and all destructive laboratory testing of field seams. The Independent Testing Laboratory shall be experienced in the performance of all conformance tests required by the CQA Plan and certified by the Geosynthetic Accreditation Institute (GAI) for each test required for the project.

4.0 MEETINGS

In order to facilitate construction of the final cover system, close coordination between the Project/Construction Manager, Landfill Engineer, Geotechnical CQA Consultant, Contractor (including appropriate Subcontractors) and Geotechnical CQA personnel is essential. To this end, the following meetings are typically scheduled:

4.1 PRE-CONSTRUCTION MEETINGS

A Pre-construction Meeting will be held at the site. At a minimum, the meeting should be attended by the Owner (or designated representative), the Construction Manager, the Landfill Engineer, the Geotechnical CQA Consultant (or designated representative), the Contractor and appropriate Geotechnical CQA staff.

In addition to the typical contract related agenda items, the following CQA specific items may also be reviewed:

- Any appropriate modifications to the Geotechnical CQA requirements.
- Development of a format for site specific documentation.
- Review of the CQA responsibilities of each individual or firm.
- Review of the lines of CQA authority and communication.
- Review of work area security and safety protocol.
- Review of the procedures for CQA project documentation and reporting, and distribution of documents and reports.

- Review of procedures for CQA submittals.
- Review of the Contractor's proposed methods of construction, (including equipment), with specific emphasis on the methods of select grading, soil mixing, stockpiling, processing, moisture conditioning and compaction.
- Review of the procedures for field and laboratory CQA testing.
- Establishment of procedures for correcting and documenting construction deficiencies.
- Conducting an initial site inspection to discuss work areas, stockpile areas, mixing tables, laydown areas, access roads, haul roads, and related items.

The meeting shall be documented by the Construction Manager and minutes shall be distributed to all parties.

4.2 PROGRESS MEETINGS

Progress Meetings shall be held in accordance with the Project Specifications. At a minimum, these meetings should be attended by the Owner (or designated representative), the Construction Manager, the Geotechnical CQA Officer and/or the Geotechnical CQA Monitors, and the Contractor. Progress meetings shall be documented by the Construction Manager or his/her representative and minutes shall be distributed to all parties. The purpose of these meetings is to:

- Discuss any health and safety related issues.
- Review scheduled work activities.
- Discuss project related problems.
- Review laboratory and field test data.
- Discuss the Contractor's personnel and equipment assignments.
- Review the previous week's activities/accomplishments and review/discuss work planned for the following week.

4.3 SPECIAL MEETINGS

Special meetings may be conducted as required to discuss problems or deficiencies. At a minimum, these meetings should be attended by the Construction Manager, appropriate Geotechnical CQA staff and the Contractor. If correction of a problem requires a design modification, the Landfill Engineer and the Geotechnical Project Director will also be present. The purpose of these meetings is to:

- Define and discuss any problems or deficiencies in the Project.
- Review possible corrective actions or solutions.
- Implement an action plan to resolve the problems or deficiencies.

Special meetings shall be documented by the Construction Manager or his/her representative and minutes shall be distributed to all parties.

5.0 GEOTECHNICAL CQA MONITORING FOR EARTH MATERIALS

5.1 GENERAL

Construction of the final cover system shall be performed in accordance with the Project Drawings and Specifications and shall be monitored, observed, and routinely sampled and tested by the Geotechnical CQA Monitors for the physical parameters described in this section.

The testing frequency presented herein is a minimum. Additional tests will be conducted by the Geotechnical CQA Monitor at any time that in the opinion of the Geotechnical CQA Monitor, additional testing is required and/or a deficiency is suspected. Retests of previously failed areas will be performed at the discretion of the Geotechnical CQA Monitor when, in his/her opinion, sufficient reworking of the area has been performed to warrant a retest.

5.2 COMPACTED FILL PLACEMENT

Material for compacted fills shall be obtained from approved borrow areas and conditioned as necessary to meet the requirements of the Project Specification. All fills shall be moisture conditioned as necessary and to the requirements of the Project Specifications, and compacted to a minimum of 90 percent compaction relative to ASTM D1557. Maximum Density/Optimum Moisture Content Testing (ASTM D1557) will be conducted at least every 5,000 c.y. or as deemed necessary by the Engineer. Field compaction testing will be conducted by nuclear gauge at a minimum frequency of four (4) test per 1,000 c.y. and evaluated by sand cone methods at a minimum frequency of one per 1,000 c.y. placed.

5.3 EXCAVATION AND PROCESSING

Selectively excavated on-site soils or approved import materials shall be screened (if necessary), to exclude particles in excess of one (1)-inch within one (1)-foot of the geosynthetics and three (3)-inches throughout the remainder of the fill. Fill soils will be dried, and/or moisture conditioned as necessary until uniformly blended material characteristics and moisture condition are attained. Processed, blended and moisture conditioned materials will then be used as engineered fill. No soils other than those approved by the Geotechnical CQA Consultant are to be used for the project.

5.4 ACCEPTANCE CRITERIA

5.4.1 GENERAL

Where test results indicate that the lift thickness, maximum particle size, homogeneity of material, moisture content or density of any portion of the work is below the project requirements, that particular portion shall be reworked or

replaced until the required condition has been attained and the resulting product meets or exceeds the requirements of the Project Specifications. No additional fill shall be placed over an area until the existing fill has been tested horizontally and vertically and determined by the Geotechnical CQA Monitor to meet the Project Earthwork Specifications. The area to be reworked will be verified by survey if in the opinion of the Geotechnical CQA Monitor conditions warrant.

5.4.2 MOISTURE CONTENT AND DENSITY

If in the opinion of the Geotechnical CQA Officer or designated representative, engineered fill materials which have been placed and/or are ready to be placed, do not visually have a uniform and homogeneous moisture content throughout the material in question, these materials will be removed, without testing, and will be reprocessed and/or reworked until, in the opinion of the Geotechnical CQA Officer or his/her designated representative, they meet the Project Specifications.

For all compacted fill materials placed, if test results indicate a relative dry density of less than that required or a moisture content outside the specified limits, then the area will be considered inadequate and will be reworked or replaced. Any reworked areas will be retested by the Geotechnical CQA Monitor to verify the reworked area meets the density and moisture content requirements.

The following table lists the minimum moisture/density requirements for compacted fill materials placed. The in-place moisture content and dry density requirements are relative to the maximum dry density and optimum moisture content as determined by ASTM D1557.

FILL TYPE	MINIMUM COMPACTION (percent)	MOISTURE CONTENT
Foundation Soil Layer	90	Optimum \pm 2%
Vegetative Soil Layer	90	Optimum \pm 2%

5.4.3 LIFT THICKNESS AND PROCESSING

If at any time the CQA Monitor observes an uncompacted lift thickness in excess of eight inches or observes material being placed without meeting the requirements for processing, stockpiling and curing, the Contractor shall immediately discontinue placing additional fills in that area. For an over thick lift, the Contractor shall immediately blade the surface to reduce the lift thickness to the Project Specifications prior to compaction. If inadequately mixed materials are placed, the Contractor shall immediately remove these materials and return them to the stockpile/processing area where they will be reprocessed.

5.4.4 GEOSYNTHETIC MATERIAL SUBGRADE

The CQA Monitor, the Contractor and the Geosynthetic installer will observe and approve the geosynthetic material subgrade prior to material deployment. The finished surface shall be free of abrupt breaks, sharp objects, or other foreign material which may damage the overlying geosynthetic. The subgrade shall be unyielding, smooth and uniform and the surface shall not be pebbly or tracked and rutted by equipment.

6.0 GEOTECHNICAL CQA MONITORING FOR GEOSYNTHETICS

6.1 GEOCOMPOSITE

The Contractor/Liner Manufacturer shall provide the Construction Manager with the following documentation:

- A properties sheet which includes all specified properties measured using test methods indicated in the Specifications.
- A description of the sampling procedure and appropriate test results.
- A certification that values given in the properties sheet are guaranteed by the Liner Manufacturer.

The Geotechnical CQA Officer shall verify that:

- The property values certified by the Liner Manufacturer meet or exceed the Project Specifications.
- The measurement of properties by the Liner Manufacturer is properly documented and the test methods used are acceptable.

Prior to shipment, the Contractor/Liner Manufacturer shall provide the Construction Manager with a quality control certificate for each roll of geocomposite. The quality control certificate shall be signed by a responsible person employed by the Liner Manufacturer, and shall include roll number and identification.

The Geotechnical CQA Officer shall:

- Verify that the quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls to be delivered.
- Review the quality control certificates and verify that the certified roll properties meet the Project Specifications.

6.1.1 GEOCOMPOSITE DELIVERY

The Contractor/Liner Subcontractor shall submit for approval by the Construction Manager, method(s) for handling and storage of geocomposite material(s) prior to installation. The Geotechnical CQA Monitor shall observe that:

- Equipment used to unload the rolls will not damage the geocomposite.
- Care is used to unload the rolls.
- All documentation required by the Specifications has been received.

Upon delivery at the site, the Geotechnical CQA Monitors shall conduct a surface inspection of all rolls for defects and damage. This inspection shall be conducted without unrolling rolls unless defects or damage are found or suspected. The Geotechnical CQA Monitors shall indicate to the Geotechnical CQA Officer any rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws.

Any damaged rolls shall be rejected and removed from the site or stored at a location, designated by the Construction Manager separate from accepted rolls. All rolls which do not have proper documentation from the manufacturer shall also be stored at a separate geocomposite material(s) received shall be maintained by the Geotechnical CQA Monitors.

The Construction Manager shall designate storage space in a location (or several locations) on-site. Storage space shall be protected by the Contractor from theft, vandalism, damage from the actions of man, weather, animals and other sources. The Geotechnical CQA Monitors shall observe that the material is not stored directly in the ground and that storage of the geocomposite provides protection against damage pursuant to ASTM D4873.

6.1.2 GEOCOMPOSITE CONFORMANCE TESTING

6.1.2.1 Tests

Upon delivery of the geocomposite, the Geotechnical CQA Monitor shall ensure that samples are obtained and forwarded to a GAI Certified Independent Laboratory for testing of conformance with the design specifications. Conformance sampling and testing will be conducted in accordance with the Project Specifications.

- Thickness (ASTM D1777)
- Mass per unit area (ASTM D3776)
- Hydraulic Transmissivity (ASTM D4716)
- Carbon Black Content (ASTM D1603)
- Tensile strength (machine direction; ASTM D1682)

Where optional procedures are noted in the test method, the requirements of the Specifications shall prevail. Updated or alternative ASTM Test Methods may be used to determine the physical properties of the geocomposite materials at the discretion of the Construction Manager.

The results of Conformance Testing will be documented by the Geotechnical CQA Officer.

6.1.2.2 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first three (3) feet. Unless otherwise specified, samples shall be three (3) feet long by the roll width. The Geotechnical CQA Monitor shall mark the machine direction on the samples with an arrow and the Manufacturer's roll identification number.

Unless otherwise specified, samples shall be taken at a rate of one per lot or one per 100,000 square feet, whichever results in the greater number of samples.

6.1.2.3 Test Results

The Geotechnical CQA Officer shall examine all results from the laboratory conformance testing. All specimens tested shall pass. If any specimen fails, the entire sample shall be considered as a failure and rejected. In this event, the geocomposite material represented by the sample shall be considered nonconformant with the Specifications, and corrective measures shall be implemented. Corrective measures shall include a rerun of the conformance testing using a portion of the same sample. If the second test passes, the Geotechnical CQA Officer may assume an error was made in the first test and the geotextile material can be accepted. If the second test fails, the Contractor/Liner Subcontractor shall remove all material represented by the sample from the work area. The decision of the Construction Manager shall be final.

6.1.3 GEOCOMPOSITE INSTALLATION

6.1.3.1 Surface Preparation

Prior to installation, the Construction Manager and Geotechnical CQA Monitors shall observe that:

- All lines and grades have been verified.
- The subgrade has been prepared in accordance with the Project Specifications and the supporting surface does not contain rocks or irregular surfaces which could damage the geocomposite.
- There are no excessively soft areas, which could result in damage to the geocomposite.

- All construction stakes and hubs have been removed.
- The Contractor/Liner Subcontractor has certified in writing that the surface on which the geocomposite will be installed is acceptable.

6.1.3.2 Placement

The Contractor/Subcontractor shall give each geocomposite panel an identification number, which shall be agreed to and used by the Geotechnical CQA Monitors and the Contractor/Liner Subcontractor. The Geotechnical CQA Monitor shall establish a chart showing correspondence between roll numbers, certification reports, and panel numbers.

During panel placement, the Geotechnical CQA Monitor shall:

- Observe the geocomposite as it is placed and record all defects and disposition of the defects (panel rejected, patch installed, etc.). All repairs are to be made in accordance with the Specifications.
- Observe that equipment used does not damage the geocomposite by handling, traffic, leakage of hydrocarbons, or other means.
- Observe that people working during installation of geocomposite do not smoke, wear shoes that could damage the geocomposite, or engage in other activities that could damage the geocomposite.
- Observe that the geocomposite is anchored to prevent movement by the wind.
- Observe that adjacent panels of geocomposite are overlapped a minimum of 18 inches where the fabric is not seamed (welded or sewn). When seamed, a three (3)-inch minimum overlap will be required.

The Geotechnical CQA Monitors shall inform both the Contractor/Liner Subcontractor and the Geotechnical CQA Officer if the above minimum conditions are not met.

The Contractor/Liner Subcontractor shall provide the Construction Manager with a panel layout plan, and shall update this plan daily as the job proceeds. No geocomposite shall be placed until the panel layout plan has been approved by the Construction Manager. During geocomposite placement, the Geotechnical CQA Monitors shall observe that:

- The geocomposite is cut only with an approved cutter, and is not torn or ripped.
- Geocomposite seaming equipment meet the Project requirements.
- The panels are being overlapped or joined in accordance with the Project Plans and Specifications.
- Any damaged roll of geocomposite is removed and replaced.

6.2 GEOMEMBRANE (LLDPE)

Delivery of geomembrane to the site will not be allowed until all required documentation and/or certifications are approved by the CM/Geotechnical CQA Team. It is the responsibility of the Contractor/Subcontractor to ensure that all required documentation and/or certifications are approved prior to shipment.

6.2.1 LLDPE MANUFACTURING

Prior to the delivery of any geosynthetic material, the Liner Manufacturer shall provide the Construction Manager with the following:

- A properties sheet for the rolls to be delivered including all specified properties measured using test methods indicated in the specifications.
- The sampling procedure and results of testing.
- A certification for each roll stating that property values given in the properties sheet are guaranteed by the Liner Manufacturer.
- The Geotechnical CQA Officer shall verify that:
 - The property values certified by the Liner Manufacturer meet the project specifications.
 - The measurements of properties by the Liner Manufacturer are properly documented and that the test methods used are acceptable.
- Prior to shipment, the Liner Manufacturer shall provide the Construction Manager with a quality control certificate for each roll of geomembrane. The quality control certificate(s) shall be signed by a responsible person employed by the Liner Manufacturer and shall include:
 - Lot and roll numbers and identification.
 - Sampling procedures and results of quality control tests. At a minimum, results shall be given for those properties identified in the Project Specifications.
 - The Geotechnical CQA Officer shall verify that the quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.
 - Review the quality control certificates and verify that the certified roll properties meet the specifications.

6.2.2 GEOMEMBRANE DELIVERY

Prior to delivery, all individual roll manufacturer certifications required by this document and/or the Project Specifications must be received and approved by the Construction Manager. Delivery of any unapproved roll will not be allowed and unapproved rolls will be transported off-site at the Contractors expense.

6.2.2.1 Transportation and Handling

All transportation and on-site handling of the geomembrane is the responsibility of the Contractor and Liner Subcontractor.

The Geotechnical CQA Officer shall observe the handling equipment used on the site and provide comment on whether it poses any risk of damage to the geomembrane. The Geotechnical CQA Officer will also observe the Contractor and Liner Subcontractor personnel's handling of the geomembrane and provide comment on whether appropriate care is being taken. Finally, the Geotechnical CQA monitor shall verify that all documentation required upon delivery has been received.

Upon delivery at the site, the Contractor, Liner Subcontractor and the Geotechnical CQA Monitor shall complete a surface observation of all rolls for defects and damage. This inspection shall be conducted without unrolling rolls unless defects or damage are found or suspected. The Geotechnical CQA Officer shall report the following to the Construction Manager:

- Rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws.
- Rolls which visually include minor repairable flaws.

Any damaged rolls shall be rejected and removed from the site or be stored at a location separate from accepted rolls as designated by the Construction Manager. All rolls which do not have proper Liner Manufacturer's documentation shall be removed from the site at the Contractors expense until all required documentation has been received and approved.

A log of all LLDPE received shall be maintained by the Geotechnical CQA Monitors.

6.2.2.2 Geomembrane Storage

The Contractor and Liner Subcontractor shall be responsible for storage of the LLDPE on-site and shall ensure the storage is consistent with the Manufacturer's recommendations. The Contractor shall coordinate with the Construction Manager to ensure that storage space is provided in a location (or several locations) such that on-site transportation and handling are minimized. Storage space shall be protected by the Contractor and Liner Subcontractor from theft, vandalism, and damage from actions of man, weather, animals and other sources. The Geotechnical CQA Monitors shall observe that the materials are not stored directly on the ground and storage of the LLDPE is completed in a fashion that protects against damage.

6.2.3 LLDPE CONFORMANCE TESTING

6.2.3.1 Tests

Upon delivery of the LLDPE, the Contractor or Liner Subcontractor shall ensure that conformance samples are obtained and forwarded to the Independent Testing Laboratory at the frequency required for testing to ensure conformance with the Project Specifications. All conformance samples will be obtained in the presence of the Geotechnical CQA Monitor or his/her designated representative.

At a minimum, conformance tests will include determination of the following characteristics for the LLDPE:

- Density (ASTM D1505A).
- Tear Resistance (ASTM D1004 Die C).
- Carbon black content (ASTM D1603).
- Thickness (ASTM D5994).
- Tensile characteristics (yield strength, elongation at yield, break strength, elongation at break) (ASTM D638).
- Puncture resistance (ASTM D4833).

Where optional procedures are noted in the test method, the requirements of the Project Specifications shall prevail.

6.2.3.2 Sampling and Testing Frequency

Unless otherwise specified, conformance samples shall be taken and tested at a rate of one per lot or one per 100,000 square feet, whichever results in the greater number of tests.

6.2.3.3 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The Geotechnical CQA Monitors shall mark the machine direction on the samples with an arrow, and the Liner Manufacturer's roll identification number.

6.2.3.4 Test Results

The results of Conformance Testing will be documented on appropriate forms. The Geotechnical CQA Officer shall examine all conformance test results and shall report any non-conformance to the Construction Manager, the Contractor and the Lining Subcontractor.

The Geotechnical CQA Officer shall examine all results from the laboratory conformance testing. All specimens tested shall pass. If any specimen fails, the entire sample shall be considered as a failure and rejected. In this event, the material represented by the sample shall be considered nonconformant with the Specifications, and corrective measures shall be implemented. Corrective measures shall include a rerun of the conformance testing using a portion of the same sample. If the second test passes, the Geotechnical CQA Officer may assume an error was made in the first test and the LLDPE material can be accepted. If the second test fails, the Liner Subcontractor shall remove all material represented by the sample from the work area.

All conformance test results must be approved by the Construction Manager prior to the LLDPE represented by the test being approved for deployment/installation. The decision of the Construction Manager shall be final.

6.2.4 LLDPE INSTALLATION

6.2.4.1 Earthwork

Surface Preparation

The Contractor shall be responsible for preparing the supporting soil according to the Project Specifications prior to installation of the LLDPE.

Prior to liner installation, the Contractor, Liner Subcontractor, Construction Manager and Geotechnical CQA Officer, shall verify that:

- All lines and grades have been checked by survey and approved by the Construction Manager.
- The subgrade has been prepared in accordance with the Project Specifications.
- The surface has been rolled and compacted to be free of surface irregularities, loose soil, and protrusions.
- The supporting soil surfaces are properly prepared and contain no sharp protrusions that could damage the LLDPE.
- There are no excessively soft areas, which could result in LLDPE damage.
- All construction stakes, hubs or other items used for grade control and/or verification have been removed.
- All certification and testing of the underlying soils is complete and approved.
- The Liner Subcontractor has certified in writing that the surface on which the LLDPE will be installed is acceptable.

The certificate of acceptance shall be given by the Liner Subcontractor to the Contractor and the Construction Manager prior to commencement of LLDPE installation in the area under consideration. The Geotechnical CQA Monitors shall have a copy of this certificate before installation of LLDPE commences in any given area.

After the supporting surface has been accepted by the Contractor and Liner Subcontractor, it shall be the Contractor and Liner Subcontractor's responsibility to indicate to the Construction Manager any change in the condition of the supporting surface that may require repair work. If the Construction Manager concurs with the Contractor and Liner Subcontractor, then the Construction Manager shall coordinate the repair of the supporting surface. The subject area will also be observed by the Geotechnical CQA Monitors who shall have the authority to reject an area even after it has been accepted by the Contractor and Liner Subcontractor.

Anchor Trench

Anchor trenches shall be excavated to the lines and widths shown on the Project Drawings, prior to LLDPE placement. The Geotechnical CQA Monitors shall observe that the anchor trenches have been constructed according to the project documents.

Slightly rounded corners shall be provided where the LLDPE adjoins the trench so as to avoid sharp bends in the LLDPE. No loose soil shall be allowed to underlie the LLDPE in the anchor trench.

Anchor trench backfill shall be compacted to at least 90 percent relative compaction (ASTM D1557) as outlined in the Specifications.

Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics. The Geotechnical CQA Monitors shall observe the backfilling operation and advise the Construction Manager of any problems.

6.2.4.2 LLDPE Placement

Field Panel Identification

A field panel (sheet) is a discrete and integral area of geomembrane which is to be seamed in the field along the edges to other field panels (i.e., a field panel is a roll or a single portion of a single roll). The Contractor or Liner Subcontractor shall assign each panel over 25 ft square feet an identification code, which shall be agreed to and used by the Geotechnical CQA Monitors, Construction Manager, Contractor and the Liner Subcontractor. The Contractor or Liner Subcontractor shall locate the code with identifying roll number near the middle of panels less than 50 feet in length and at both ends of any panel over 50 feet in length. The Geotechnical CQA Monitors shall establish a chart showing correspondence between roll numbers, certification reports, and the panel identification code. The field panel identification code shall be used for all Geotechnical CQA records. A geomembrane panel placement log will be maintained by the Geotechnical CQA Monitors.

Field Panel Placement

The Geotechnical CQA Monitors shall record the identification code, location and date of installation of each field panel.

During panel placement, the Geotechnical CQA Monitors shall:

- Verify that field panels are installed in general accordance with the panel layout plan, as approved or modified by the Construction Manager/Landfill Engineer.
- Observe the panel surface as it is deployed and record all panel defects and disposition of the defects. All repairs are to be made in accordance with the Specifications.
- Observe that the equipment used does not damage the LLDPE by handling, trafficking, leakage of hydrocarbons, or by other means.
- Observe that the surface beneath the LLDPE has not deteriorated since previous acceptance.
- Observe that there are no stones, construction debris, or other items beneath the LLDPE, which could cause damage.
- Observe that the LLDPE is not dragged across an unprepared surface. If the LLDPE is dragged across an unprepared surface, it shall be inspected for scratches and repaired or rejected, if necessary.
- Observe that the method used to unroll the panels does not cause scratches or crimps in the LLDPE and does not damage the supporting soil surface.
- Record weather conditions including temperature, wind, and humidity. The LLDPE shall not be deployed in the presence of excess moisture (fog, dew, mist, etc.), high winds and extreme temperatures as determined by the Geotechnical CQA Officer.
- Observe that people working during the installation of LLDPE do not smoke, wear shoes, or engage in activities that could damage the LLDPE.
- Observe that the method used to deploy the panel minimizes wrinkles and that the panels are anchored to prevent movement by the wind.
- Observe that direct contact with the LLDPE is minimized; (i.e., the LLDPE is protected by geotextiles, extra LLDPE, or other suitable materials, in areas where excessive traffic may be expected).

The Geotechnical CQA Monitors shall inform the Contractor, the Liner Subcontractor and the Construction Manager if the above conditions are not met.

After placement and prior to seaming, the Geotechnical CQA Monitors shall inspect each panel for damage. The Geotechnical CQA Monitors shall advise the Construction Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected shall be marked and their removal from the work area recorded by the Geotechnical CQA Monitors.

6.2.4.3 Field Seaming

The Contractor shall provide the Construction Manager and Geotechnical CQA Officer with a seam and panel layout plan and shall update this plan daily as the job proceeds. No panels shall be seamed until the panel layout plan has been approved by the Construction Manager. A seam numbering system shall be agreed to by the Geotechnical CQA Monitors, Construction Manager, Contractor and Liner Subcontractor prior to the start of seaming operations.

Prior to seaming, each seaming apparatus (welder) shall be tested in accordance with the Specifications to determine if the equipment is functioning properly. The Geotechnical CQA Monitors shall observe all trial weld operations and record the results. It is important that the trial welds be completed under conditions similar to those under which the panels will be seamed. If at any time the Geotechnical CQA Monitor believes that an operator or seaming apparatus is not functioning properly, a test shall be performed on a trial weld. If there are large changes in temperature, humidity, or wind speed, the trial weld test shall be repeated. Laboratory tests may be carried out at the discretion of the Geotechnical CQA Monitors to verify field test results.

During seaming operations the Geotechnical CQA Monitors shall observe that:

- The Liner Subcontractor has the number of welders and spare parts agreed to in the pre-construction meeting.
- Equipment used for seaming will not damage the LLDPE.
- The extruder is purged prior to beginning a seam until all the heat-degraded extrudate is removed (extrusion welding only).
- Seam grinding has been completed less than 1 hour before seam welding (extrusion welding only).
- The ambient temperature measured 6 inches above the LLDPE surface is between 40 and 105 degrees Fahrenheit and relative humidity is less than 80 percent.
- The end of welds more than 5 minutes old, are ground to expose new material before restarting a weld (extrusion welding only).
- The weld is free of dust and other debris.
- For cross seams, the seam is ground to a smooth incline prior to welding.
- The seams are overlapped in a downgradient direction with a minimum overlap of 4 inches.
- No solvents or adhesives are present in the seam area.
- The procedure used to temporarily hold the panels together does not damage the panels and does not preclude Geotechnical CQA testing.
- The panels are being seamed in accordance with the Project Plans and Specifications using approved equipment with gauges giving applicable temperatures.
- There is no free moisture in the weld area.

- The electric generator is placed on a smooth base such that no damage occurs to the LLDPE.
- A smooth insulating plate or fabric is placed beneath the hot welding apparatus after use.
- The geomembrane is protected from damage in heavily trafficked areas.

The Geotechnical CQA Monitors shall log all appropriate temperatures and conditions, and shall log and report to the Geotechnical CQA Officer any non-compliance.

Trial Seams

Trial seam samples are not removed from installed seams, but are made along side the seaming work area by the Liner Subcontractor using a fragment of the same LLDPE sheet and the same installation procedures as for the LLDPE installation itself. As such, they are considered nondestructive samples. Such trial seams shall be made at the beginning of each seaming period (start of day, mid-day, and anytime the equipment is shut down or the seaming operation is suspended for more than 1/2 hour) for each piece of seaming equipment used that day. In addition, each welder shall make at least one trial seam each day. Trial seams shall be made under the same conditions as those anticipated for actual seams.

The trial seam sample shall be at least 3 ft. long by 1 ft. plus the seam width wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as per the Specifications.

Two opposite specimens, each 1-inch wide, shall be cut from the trial seam sample by the Contractor and/or Liner Subcontractor. Under the observation of a Geotechnical CQA Monitor, the specimens shall be tested by the Liner Subcontractor in shear and peel using a field tensiometer to verify that seams satisfy peel and tensile strength requirements. If a specimen fails, the seaming equipment and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial welds are achieved. After completing a successful trial/nondestructive sample, the Contractor and/or Liner Subcontractor shall cut a 2' x 2' remnant from the sample and mark the welder number, date, time, ambient temperature, welder temperature, and speed and submit it to the Geotechnical CQA Monitor who will assign an identification number and enter the information on the non-destructive sample form.

The results of field tests carried out on trial seams shall be documented by the Geotechnical CQA Monitors.

General Seaming Procedure

Unless otherwise specified, the general seaming procedure to be used by the Contractor and/or Liner Subcontractor shall be as follows:

- All LLDPE seams shall be overlapped a minimum of four (4) inches.
- "Fishmouths" or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut "fishmouths" or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same LLDPE extending a minimum of 6 inches beyond the cut in all directions. All corners of the patch shall be rounded with a 1-inch minimum radius.
- Adjacent to anchor trenches, seaming shall extend up the panels a minimum of 12 inches past the crest of the anchor trench.
- All cross seams shall be offset at least two feet from the cross seam of the adjacent panel and be extrusion or wedge welded where they intersect.

The Geotechnical CQA Monitors shall observe that the above seaming procedures are followed, and shall inform the Construction Manager if they are not.

6.2.5 CONSTRUCTION TESTING

6.2.5.1 Nondestructive Seam Testing

The Contractor and/or Liner Subcontractor shall non-destructively test all field seams over their full length using a vacuum test unit, spark detector, or an air pressure test (for double wedge fusion seams only), as described below. The purpose of nondestructive tests is to check the continuity of seams. It does not provide any information on seam strength. Continuity testing shall be carried out as the seaming work progresses, not at the completion of field seaming.

Visual Inspection

All seams shall be visually evaluated by the Contractor and/or Liner Subcontractor as the installation progresses and again at completion of the installation. Defective and questionable sections shall be clearly marked and repaired as necessary.

Vacuum Box Testing

If the fillet weld, extrusion lap weld or single hot-wedge fusion lap weld technique is used to weld seams, the Contractor and/or Liner Subcontractor shall further test all seams and repairs in the LLDPE by vacuum box. The vacuum box shall be an American Vacuum Seam Tester, Series A100 as manufactured by American Parts and Service Company, Alhambra, California, or an approved equal. All vacuum box testing shall be done in the presence of the Geotechnical

CQA Monitor. The area to be tested shall be cleaned of all dust, debris, dirt and other foreign matter. A soap solution shall be applied to the test area with a brush, paint roller or spray bottle and a minimum vacuum of 10 inches of mercury (Hg) (5 psi) shall be induced and held as long as necessary to visually inspect and mark for repair any suspicious areas as evidenced by bubbles in the soap solution.

Spark Testing

If the fillet weld is used to weld seams, the Contractor and/or Liner Subcontractor may, in lieu of vacuum box testing, test all seams and repairs in the LLDPE liner by using a high voltage spark detector, similar to Tinker and Rasor Holiday Detector (Model AP-W). The setting of the detector shall be 20,000 volts. In order to conduct this test, all seams to be tested shall be provided with 24-30 gauge copper wires properly embedded in the seams and grounded. All spark testing shall be done in the presence of the Geotechnical CQA Monitor. All defective areas shall be marked for repair.

Air Pressure Test

If the double hot-wedge welding technique is used, the Contractor and/or Liner Subcontractor shall further test all seams in the LLDPE lining by using the air pressure test which consists of inserting a needle with gauge in the air space between welds. Air shall be pumped to 40 psi within the weld void and held for at least 5 minutes. If the pressure loss exceeds 2 psi within the weld void during air pressure testing, the outside weld edge (not free edge) shall be sprayed with a soap solution and visually examined for bubbles. If no bubbles appear, the problem is with the inside weld and the seam is acceptable. If any bubbles appear, the defect shall be repaired by extrusion welding and tested by vacuum box and spark detector.

If pressure loss is not more than 2 psi, the opposite end of the seam will be punctured to release the air. If a blockage is present, it will be located and tests on both sides of the blockage will be completed. All penetration holes created during testing shall be sealed by patching and extrusion welding.

Responsibilities of the Geotechnical CQA Monitors

The Geotechnical CQA Monitor/Manager shall:

- Observe and record the continuity of all testing.
- Record the location seam/panel number, date, time, equipment number, Geotechnical CQA Monitor name, test number, welding technician's name, weld, sheet and ambient temperatures and results of all testing.
- Mark the failed areas with a waterproof marker compatible with the lining material and inform the Contractor and/or Liner Subcontractor and the Construction Manager of any required repairs.

- Observe that all testing is completed in accordance with the Project Specifications.
- Observe that all repairs are completed and tested in accordance with the Project Specifications.

6.2.5.2 Destructive Seam Testing

Destructive seam tests shall be performed at selected locations. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

Destructive sampling involves samples that have been removed from the installed field seams by the Contractor/Liner Subcontractor. Test locations shall be determined at the discretion of the Geotechnical CQA Monitors and the Contractor/Liner Subcontractor shall not be informed in advance of the locations where the seam samples will be made or will be removed.

Destructive samples shall be delivered to the Geotechnical CQA Officer by the Contractor/Liner Subcontractor and shipped to the Independent Testing Laboratory. All costs associated with the collection, repair, shipping and testing of destructive samples will be borne by the Contractor/Liner Subcontractor.

A minimum of one destructive sample per 500 feet of field seam shall be obtained. This average frequency will be used for the entire installation with the actual frequency of samples based on performance as determined by the Geotechnical CQA Officer.

Additional samples may be removed if the Geotechnical CQA Monitor observes a suspect seam.

6.2.5.3 Sampling Procedures

Samples shall be made or removed by the Contractor/Liner Subcontractor at locations selected by the Geotechnical CQA Monitors as the seaming operation progresses. The Geotechnical CQA Monitor shall:

- Observe making and/or removal of samples.
- Mark each sample with an identifying number, which contains the seam number. (For nondestructive samples the seam number welded just prior to making a sample will be marked on the sample).
- Record sample location on the panel layout drawing and enter the information on a Destructive Sample Log Form.
- Record the sample location, date and time taken, weather conditions, and reason the sample was made and/or taken (e.g., random sample, visual appearance, result of a previous failure, etc.).

- Mark sample identifying number on LLDPE adjacent to the location where the sample was taken.

All holes in the LLDPE resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described herein. The continuity of the new seams in the repaired area shall be tested according to procedures described herein.

6.2.5.4 Size of Samples

Two types of samples shall be made or removed at each location. First, two samples shall be removed for field testing. Each of these samples shall be 1-inch wide with a length of 12 inches plus the seam width. For destructive sampling, the sample shall be taken perpendicular to the seam and the distance between these two samples shall be 38 inches. Samples designated for laboratory testing shall be that portion of seam located between the two samples taken for field testing. The samples for laboratory testing shall be 36 inches long with a width of 12 inches plus the seam width. The seam shall be centered lengthwise. The samples for laboratory testing shall be cut into three equal parts and distributed as follows:

- One part for the Independent Testing Laboratory for testing.
- One part to the Contractor/Liner Subcontractor.
- One part to the Construction Manager for archive storage.

6.2.5.5 Field Testing

The two 1-inch wide samples shall be tested in the field for peel adhesion and bonded seam strength (shear) by the Contractor/Liner Subcontractor, and shall not fail in the seam, but shall have a film tearing bond (FTB). If one or both of the samples fails in either peel or shear, the Contractor/Liner Subcontractor can, at his/her discretion, (1) reconstruct or cap strip the seam between passed test locations, or (2) take two additional test samples 10 feet on either side of the point of the failed test and repeat this procedure. If the second test passes, the Contractor/Liner Subcontractor shall reconstruct or cap strip the same between the two passed test locations. If subsequent tests fail, the procedure is repeated until the length of the poor quality seam is established. Repeated failures indicate that either the seaming equipment and/or operator is not performing properly, and appropriate action shall be taken.

6.2.5.6 Laboratory Testing

Once the field tests have passed, a sample shall be recovered from between passing field sample locations for testing by the GAI approved Independent Testing Laboratory. Destructive test samples shall be packaged and shipped to the laboratory by the Geotechnical CQA Monitors and will be handled in a

manner which will not damage the test sample. The Construction Manager will be responsible for storing the archive samples.

All specimens of a field weld sample tested by the Independent Testing Laboratory shall pass. If any specimen fails, the entire sample shall be considered as a failure, and the field weld shall be rejected. In this event, the field seam(s) shall be rejected as being nonconformant with the Specifications, and corrective measures shall be implemented.

For destructive samples that have failed, corrective measures shall include a rerun of the weld test using the same sample. If the second test passes, the Geotechnical CQA Monitor may assume an error was made in the first test and the field seam may be accepted. If the second test fails, the Contractor/Liner Subcontractor shall reconstruct or cap strip the field seam between any two previous passed seam locations, which include the failed seam or shall go on both sides of the failed seam location (10-feet minimum), take another sample each side and test both in the independent laboratory.

If both samples pass, the Contractor/Liner Subcontractor shall reconstruct or cap strip the field seam between the two passing locations. If either fails, the Contractor/Liner Subcontractor shall repeat the process of taking samples for testing by the Independent Testing Laboratory. In all cases, acceptable field seams must be bounded by two passed test locations. In cases involving more than 50 feet of reconstructed or cap stripped seam, the reconstructed or cap stripped seam shall also be tested. The results of the Independent Testing Laboratory govern seam acceptance. In no case shall field testing of installed seams be used for final acceptance.

Testing shall include peel adhesion and bonded seam strength (shear; ASTM D6392). At least five specimens each shall be tested for peel and sheer. Minimum test values are presented in the Specifications. The Independent Testing Laboratory shall provide test results within 24 hours after receipt of samples for testing. Certified test results shall be provided within 5 days. The Geotechnical CQA Monitor shall document all test results on appropriate forms and shall immediately notify the Geotechnical CQA Officer, Construction Manager and/or Contractor/Liner Subcontractor in the event of a failed test.

The Contractor/Liner Subcontractor's laboratory test results shall be presented to the Geotechnical CQA Officer for comments.

6.2.6 DEFECTS AND REPAIRS

6.2.6.1 Identification

All seams and non-seam areas of the LLDPE shall be examined by the Geotechnical CQA Monitors for identification of defects, holes, blisters,

undispersed raw materials and any sign of contamination by foreign matter. Because light reflected by the LLDPE helps to detect defects, the surface of the LLDPE shall be clean at the time of examination. The LLDPE surface shall be cleaned by the Contractor/Liner Subcontractor if the amount of dust or mud inhibits examination.

Each suspect location as identified by the Geotechnical CQA Monitors, both in seam and non-seam areas, shall be non-destructively tested using the methods described herein, as appropriate. Each location which fails the nondestructive testing shall be marked by the Geotechnical CQA Monitor and then repaired and re-tested by the Contractor/Liner Subcontractor. Work shall not proceed with any materials that will cover locations that have been repaired until laboratory test results with passing values have been obtained.

6.2.6.2 Repair Procedures

Any portion of the LLDPE with a flaw or which fails a nondestructive or destructive test shall be repaired in accordance with the Specifications. The Geotechnical CQA Monitor shall locate and describe all repairs on the appropriate forms. Repair procedures include:

- Patching - used to repair large holes, tears, large panel defects, and destructive sample locations that are less than 25 ft² in total area.
- Extrusion - used to repair relatively small defects in panels and seams.
- Capping - used to repair failed welds or liner seams where welds cannot be non-destructively tested.
- Removal - used to replace areas with large defects where the preceding methods are not appropriate. Also used to remove excess material (wrinkles) from the installed LLDPE.

6.2.6.3 Seam Test Summary

Documentation of all nondestructive and destructive seam testing results, including repairs, shall be summarized by the Geotechnical CQA Officer.

6.2.7 WRINKLES

When placing soil or drain materials over the LLDPE, temperature changes or creep may cause wrinkles to develop in the LLDPE. Any wrinkles that can fold over shall be repaired either by cutting out excess material or, if possible, allowing the LLDPE to contract due to temperature reduction. In no case shall material be placed over the LLDPE that could result in the LLDPE folding. All folded LLDPE shall be removed. No material shall be placed in areas where liner is not in contact with the supporting subgrade.

6.2.8 ANCHOR TRENCH

The anchor trench shall be adequately drained to prevent ponding or softening of the adjacent soils while the trench is open. The anchor trench shall be backfilled and compacted as outlined in the Specifications. Fill soils shall consist of on-site granular soil essentially free of organic and deleterious material and approved by the Geotechnical CQA Monitor and Construction Manager. The material shall have a maximum particle size of 1 inch.

Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics. The Geotechnical CQA Monitor shall observe the bottom of the trenches prior to fill placement to ensure they are free of loose and disturbed materials. The Geotechnical CQA Monitor shall also observe the backfilling and compaction operation, and shall notify the Geotechnical CQA Officer and the Construction Manager of work performed not in accordance with the Project Specifications.

6.2.9 LLDPE ACCEPTANCE

The Contractor/Liner Subcontractor shall retain all ownership and responsibility for the LLDPE until acceptance by the Owner. The LLDPE shall be accepted by the Owner when:

- The installation is finished and approved.
- All seams have been inspected and approved.
- All required laboratory tests have been completed and approved.
- All required Contractor/Liner Subcontractor supplied documentation has been received and approved.
- All record drawings have been completed and approved.

6.2.10 LINER MATERIALS

The Geotechnical CQA procedures indicated in this section are intended to allow the installation of materials in contact with the geosynthetics without causing damage to the LLDPE.

Important points for Quality Assurance of materials in contact with LLDPE include:

- A geotextile or drainage medium approved by the Construction Manager shall be installed above the LLDPE.
- Equipment used for placing soil shall not be driven directly on the LLDPE.
- In heavily trafficked areas, such as access ramps, soil thickness should be at least three (3) feet.
- Placement of soils, gravels, sand or other types of earth materials on top of the LLDPE shall not be performed until all destructive and nondestructive testing

has been performed and accepted. Placement of overlying earth materials shall be performed in a manner to minimize wrinkles. Equipment operators shall be briefed on methods of placement relative to thermal expansion and contraction of the LLDPE.

- Soil material(s) placed on top of the LLDPE shall be stockpiled and displaced off the stockpile to create a cascading effect of the material on top of the LLDPE.

The Geotechnical CQA Monitors shall inform the Geotechnical CQA Officer if the above conditions are not fulfilled.

7.0 DOCUMENTATION

To provide evidence of satisfactory work performance, all stages of liner construction shall be documented. The information shall be recorded on a standardized form or in a bound field logbook.

7.1 DAILY SUMMARY REPORTS

The purpose of daily summary report is to provide a chronological framework for identifying and recording all other reports. Inspection data sheets will record construction activities, including: results of continuous visual observations; laboratory/field test data; sampling; review of test results; repairs; problems; solutions; and general field activity. The daily summary report will include a daily field inspection report and a daily test summary report, as discussed below.

7.1.1 DAILY FIELD INSPECTION REPORT

The Geotechnical CQA Monitor(s) shall keep a daily field inspection report of project activities. At a minimum, this report shall include the following:

- Date and project identification.
- Field activity and work locations.
- Summaries of field communications.
- Summary of equipment used and personnel performing work (i.e. superintendent, welders, etc.).
- Work activity monitored, its general location on-site, and any related test results.
- Record of material sampling and testing activities.
- Any variance from specified methods and standards.
- Estimated quantities of material placed and compacted.
- Unusual events.
- Actions regarding acceptance/rejection of work.
- Identification of construction problems and their solution or disposition summarized into a corrective measures report.

- Weather conditions.
- Signature of person preparing the report.

The corrective measures report will include detailed descriptions of materials and/or workmanship that do not meet a specified design and will be cross referenced to the specific inspection data sheets where the problem was identified and corrected.

7.1.2 DAILY TEST SUMMARY REPORT

A daily test summary report of the field and laboratory tests conducted for the CQA of the earth materials portion of the cover will be prepared under the direction of the Geotechnical CQA Officer. The daily test summary report will include:

- Locations and results of all field and laboratory tests with pass/fail comment.
- Results of all retests for failed areas with remarks showing the corrective action taken before the retests. If retest(s) also show a rejection, final corrective action shall be noted.

Both the daily field inspection report and the daily test summary report shall be reviewed by the Geotechnical CQA Officer and shall be submitted to the Construction Manager. One complete set of both the daily reports and test summary report shall be kept on-site by CQA personnel at all times.

7.2 ACCEPTANCE REPORTS

Acceptance Reports shall be prepared by the Geotechnical CQA Officer and submitted to the Construction Manager. Each Acceptance Report shall include the above daily reports (Section 7.1) and summarize the work activities, deficiencies, and corrective action implemented. These reports will indicate that the materials and construction processes have been completed according to the specified design. These reports will be included in the project files and available to regulatory agencies upon request.

7.3 PHOTO DOCUMENTATION

A photographic record shall be prepared by the Construction Manager as part of the construction control activities. Photographs shall be in color and shall include photographs of construction activities, problem areas, corrective actions, and final constructed features. Photographs shall be identified with the landfill site designation, the date taken, the location, and a description of the activity covered by the photograph.

7.4 AS-BUILT DOCUMENTATION

As the work is completed, a final Geotechnical As-Built report shall be prepared under the direction of the Geotechnical CQA Consultant utilizing the results of tests and observations completed during construction to document that the CQA Plan was implemented as proposed and that construction proceeded in accordance with design criteria, plans and specifications. This As-Built report shall include a laboratory test results summary and documentation of typical construction conditions and procedures. The As-Built report will be signed by the CQA Officer, who is a registered civil engineer or certified engineering geologist and submitted to the Owner. Upon completion, the facility will store all original documents so that they are protected from damage throughout the post-closure maintenance period, yet can be readily accessed.